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IMPACT OF THE WAY OF LAND USE ON DEHYDROGENASE ACTIVITY IN THE SOILS OF THE SILESIAN FOOTHILLS

WPŁYW SPOSOBU UŻYTKOWANIA NA AKTYWNOŚĆ DEHYDROGENAZ GLEB POGÓRZA ŚLĄSKIEGO

Abstract: The objective of the research was to check the relations between dehydrogenase activity and the way of land use. Soil material collected from 6 soil profiles located in the area of the Silesian Foothills was used in the research work. The results showed higher dehydrogenase activity in the surface horizons of grassland soils (12.40–17.34 $cm^3 \cdot kg^{-1} \cdot 24^{-1}$) than in the analogous horizons of arable soils (4.58–7.06 $cm^3 \cdot kg^{-1} \cdot 24^{-1}$). It was observed that in all profiles dehydrogenase activity was higher in surface horizons than in the deeper ones. Dehydrogenase activity depended mainly on the way of land use and the soil concentrations of organic carbon and total nitrogen.

Keywords: Silesian Foothills, soil biological activity, dehydrogenases, land use

Enzymatic activity is one of the indirect forms of soil biological activity assessment. The source of enzymes in soil are microorganisms, plant roots and soil fauna, but the main role in creating enzymatic activity is ascribed to microorganisms [1]. Dehydrogenases occurring in live cells are a group of oxyreductases responsible for the catalysis of organic compound oxidation reaction, which makes them a good indicator of the intensity of respiration metabolism in soil microorganisms [2]. Dehydrogenase activity depends on moisture, temperature and soil reaction but also on its concentrations of organic carbon, micro- and macroelements [3]. Moreover it is also affected by the heavy metal content in soil [4].

The research was conducted to determine the impact of the way of land use on soil enzymatic activity through comparing dehydrogenase activity in individual horizons of soil profiles used as arable lands and meadows, as well as testing the dependency between their activity and essential chemical soil properties.

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Materials and methods

The work used soil material collected from 6 soil profiles formed from weathering material of the Silesian unit of the Carpathian Flysch, localized in the Silesian Foothills. Soil pits were arranged in pairs (P1R-P1Z, P2R-P2Z, P3R-P3Z) on the neighbouring arable lands and grasslands so as to eliminate the influence of soil forming factors, other than land use. The soil samples were subjected to standard soil analyses to determine their texture (using the areometric-sieve method acc. to PN-R-04032), pH in H_2O and KCl (using electrometric method), total exchangeable bases (TEB) through determining individual cations after their extraction from the soil with CH_3COONH_4 (where Ca^{2+}, K^+ and Na^+ were assessed using flame photometry and Mg^{2+} using AAS method), hydrolytic acidity (by Kappen method), organic carbon content (by means of modified oxydimetric Tiurin's method), total nitrogen (using Kjeldahl method) and dehydrogenase activity (using Caside et al method) [5].

Spearman rank coefficients between dehydrogenase activity and analyzed soil properties were computed as part of the statistical elaboration of results.

Results and discussion

The analyzed soils belong to brown soils – *Haplic Cambisols* (*Eutric*) and to pseudogley soils – *Haplic Stagnosols* [6, 8]. The soils were characterized by a texture of silt loam and sandy silt (PN-R-04032) and their pH varied from very acid to slightly acid (Table 1). The soils differed in their cation exchange capacity (CEC) in the top horizons of P1R and P2R used as arable lands (and limed), which was visibly higher than in the analogous parts of P1Z and P2Z soil profiles managed as meadows (without liming) (Table 1). In P3R and P3Z profiles the base saturation ratio (V) was approximate and reached about 60 % in the surface horizons.

Dehydrogenase activity in the top A1h horizons of sodded soils (12.40–17.43 cm^3 $H_2 \cdot kg^{-1} \cdot 24^{-1}$) was between twice and thrice higher than in deeper A2h humus horizons of these soils (4.61–5.93 cm^3 $H_2 \cdot kg^{-1} \cdot 24^{-1}$) and in the arable Ap layer of the arable lands (4.58–7.06 cm^3 $H_2 \cdot kg^{-1} \cdot 24^{-1}$). The sod horizon of the limed soil (P3Z) revealed the highest value of enzymatic activity. These results confirm an important role of roots in developing enzymatic activity, among others mentioned by Pancholy and Rice [7]. The rhizosphere is characterized by a numerous population of microorganisms accompanied by heightened activity of fauna feeding on microorganisms and roots.

In the subsurface horizons of the analyzed soils dehydrogenase activity was much lower (0.05–1.51 cm^3 $H_2 \cdot kg^{-1} \cdot 24^{-1}$) and did not reveal diversification in individual soil pairs. The only exception was the 55–69 cm horizon of the P3Z profile which revealed higher enzymatic activity (Fig. 1) and content of C_{org} and N_{tot} (Table 1). It might have been caused by numerous fauna – turbulences occurring there. The obtained results were in accordance with those obtained by Doran [after 7], which demonstrated that activity of dehydrogenases, water content, organic substance, organic C and total N were higher in the topsoil horizons of soils fallowed for long periods of time than in cultivated soils. In lower situated horizons these regularities were not observed.

Table 1

Selected chemical properties of studied soils

Profil	Depth [cm]	Horizon	pH		DHA $[cm^3\ H_2 \cdot kg^{-1} \cdot 24^{-1}]$	H_h	S	CEC	BS	$C_{org.}$	$N_{tot.}$
			H_2O	KCl		[mmol(+)kg^{-1} soil]			[%]		
	0–22	Ap	6.2	5.0	4.58	53.7	95.4	149.11	64.0	1.75	0.22
	22–35	Ah	6.3	5.1	5.21	50.8	98.9	149.64	66.1	1.77	0.19
PR1	35–45	Bbr1C	6.3	4.9	1.30	41.8	71.7	113.51	63.2	0.67	0.08
	45–61	Bbr2C	6.1	4.7	0.49	35.8	71.1	106.93	66.5	0.50	0.09
	50–75	IIBbrC	5.8	4.5	0.30	34.3	50.1	84.4	59.3	0.25	0.04
	0–10	A1h	5.5	4.4	12.40	74.6	62.2	136.82	45.5	2.16	0.22
	10–22	A2h	6.0	4.7	5.93	50.8	72.3	123.08	58.8	1.43	0.17
P1Z	22–40	B1br	6.1	4.6	1.26	44.8	69.3	114.03	60.7	0.62	0.07
	40–57	B2br	5.9	4.4	0.72	44.8	56.1	100.89	55.6	0.56	0.09
	57–87	IIBbrC	5.9	4.7	0.09	35.8	47.1	82.9	56.8	0.31	0.08
	0–25	Ap	5.7	4.3	7.06	56.7	78.6	135.30	58.1	1.68	0.17
P2R	25–44	A/Gg	4.9	4.0	0.15	38.8	67.0	105.85	63.3	0.34	0.06
	44–62	G1g	4.7	3.8	0.11	58.2	61.4	119.58	51.3	0.19	0.05
	62–87	G2g	5.8	4.5	0.30	77.6	44.9	122.48	36.6	0.16	0.04
	0–8	A1h	5.5	4.3	14.05	88.1	43.4	131.43	33.0	2.40	0.21
	8–25	A2h	5.3	3.9	4.61	65.7	53.6	119.29	45.0	1.69	0.17
P2Z	25–58	G1g	5.1	3.7	0.18	56.7	66.5	123.23	54.0	0.16	0.02
	58–84	G2g	5.2	3.6	0.34	71.6	50.3	121.91	41.2	0.10	0.03
	84–125	G3g	5.1	3.7	0.05	65.7	60.7	126.39	48.0	0.12	0.02
	0–20	Ap	5.6	4.2	5.95	58.2	89.0	147.24	60.5	1.69	0.2
P3R	20–41	G1g	5.3	4.0	0.82	38.8	51.1	89.9	56.8	0.38	0.06
	41–62	G2g	5.0	3.7	0.05	53.7	68.3	122.00	56.0	0.21	0.03
	62–80	C1g	4.9	3.5	0.09	71.6	69.0	140.65	49.1	0.22	0.05
	0–8	A1h	5.6	4.2	17.34	65.7	98.6	164.27	60.0	2.44	0.29
	8–32	A2h	5.6	4.1	5.74	71.6	74.7	146.34	51.1	1.84	0.20
P3Z	32–55	A2h/Gg	5.7	4.2	0.52	62.7	74.3	136.99	54.2	0.68	0.10
	55–69	Gg	5.2	3.8	1.51	59.7	65.8	125.45	52.4	0.84	0.11
	69–95	C1g	5.2	3.8	0.13	59.7	63.7	123.39	51.6	0.22	0.04

DHA – dehydrogenase activity, H_h – hydrolitic acidity, S – total exchangeable bases, CEC – cations exchange capacity, BS – base saturation.

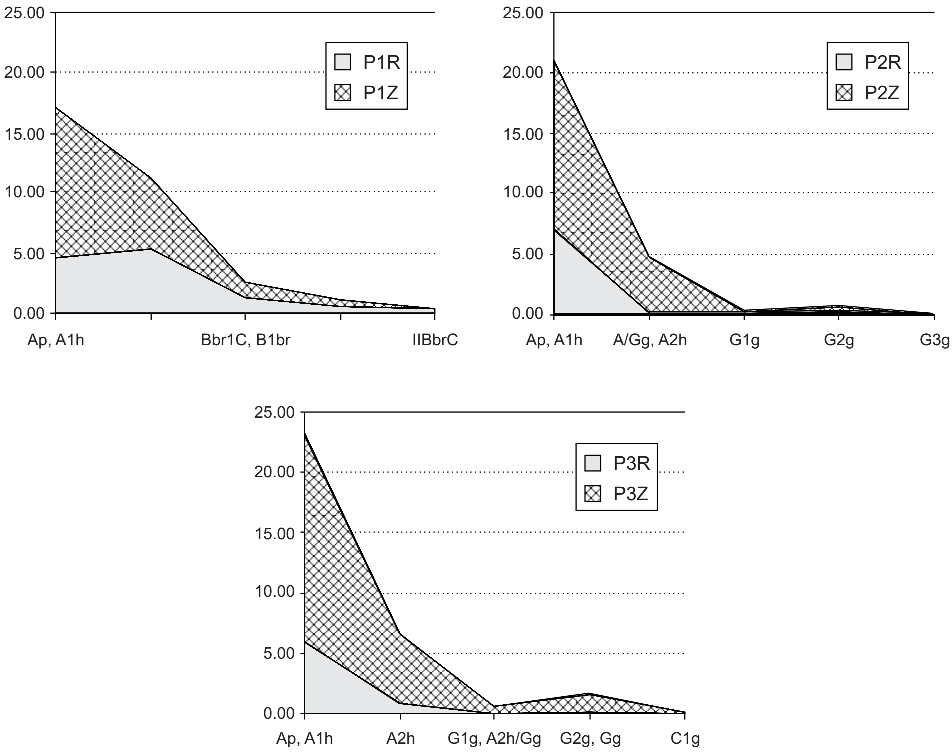

Fig. 1. Comparison of dehydrogenase activity in selected pairs

The computed Spearman rank coefficients confirmed a high and statistically significant dependency between dehydrogenase and organic carbon activity ($r = 0.8783$) and total nitrogen ($r = 0.8675$).

Conclusions

1. Dehydrogenase activity in soils depended on the way of land use – it was much higher in the surface horizons of sodded soils than in the analogous horizons of arable lands.
2. Surface horizons of the analyzed soils were characterized by much higher dehydrogenase activity than the subsurface horizons.
3. Dehydrogenase activity to a great degree depended on organic carbon and total nitrogen content in soil.

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WPŁYW SPOSOBU UŻYTKOWANIA NA AKTYWNOŚĆ DEHYDROGENAZ GLEB POGÓRZA ŚLĄSKIEGO

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Abstrakt: W przeprowadzonych badaniach sprawdzono zależności pomiędzy aktywnością dehydrogenaz a sposobem użytkowania gleb. W pracy wykorzystano materiał glebowy z 6 profili glebowych, zlokalizowanych na terenie Pogórza Śląskiego. Aktywność dehydrogenaz w powierzchniowych poziomach gleb zadarnionych była większa (12,40–17,34 $cm^3H_2 \cdot kg^{-1} \cdot 24^{-1}$) niż w analogicznych poziomach gleb gruntów ornych (4,58–7,06 $cm^3H_2 \cdot kg^{-1} \cdot 24^{-1}$). We wszystkich profilach stwierdzono większą aktywność dehydrogenaz w powierzchniowych poziomach w porównaniu do poziomów niżej leżących. W badanych glebach aktywność dehydrogenaz zależała głównie od sposobu użytkowania oraz od zawartości węgla organicznego i azotu ogólnego.

Słowa kluczowe: Pogórze Śląskie, aktywność biologiczna gleb, dehydrogenazy, sposób użytkowania